State of Oklahoma

OWRB

WATER RESOURCES BOARD

the water agency

ADAPTIVE MANAGEMENT FOR LOW DISSOLVED OXYGEN IN THE GRAND AND HUDSON LAKE TAILRACES

Lance Phillips, Program Manager

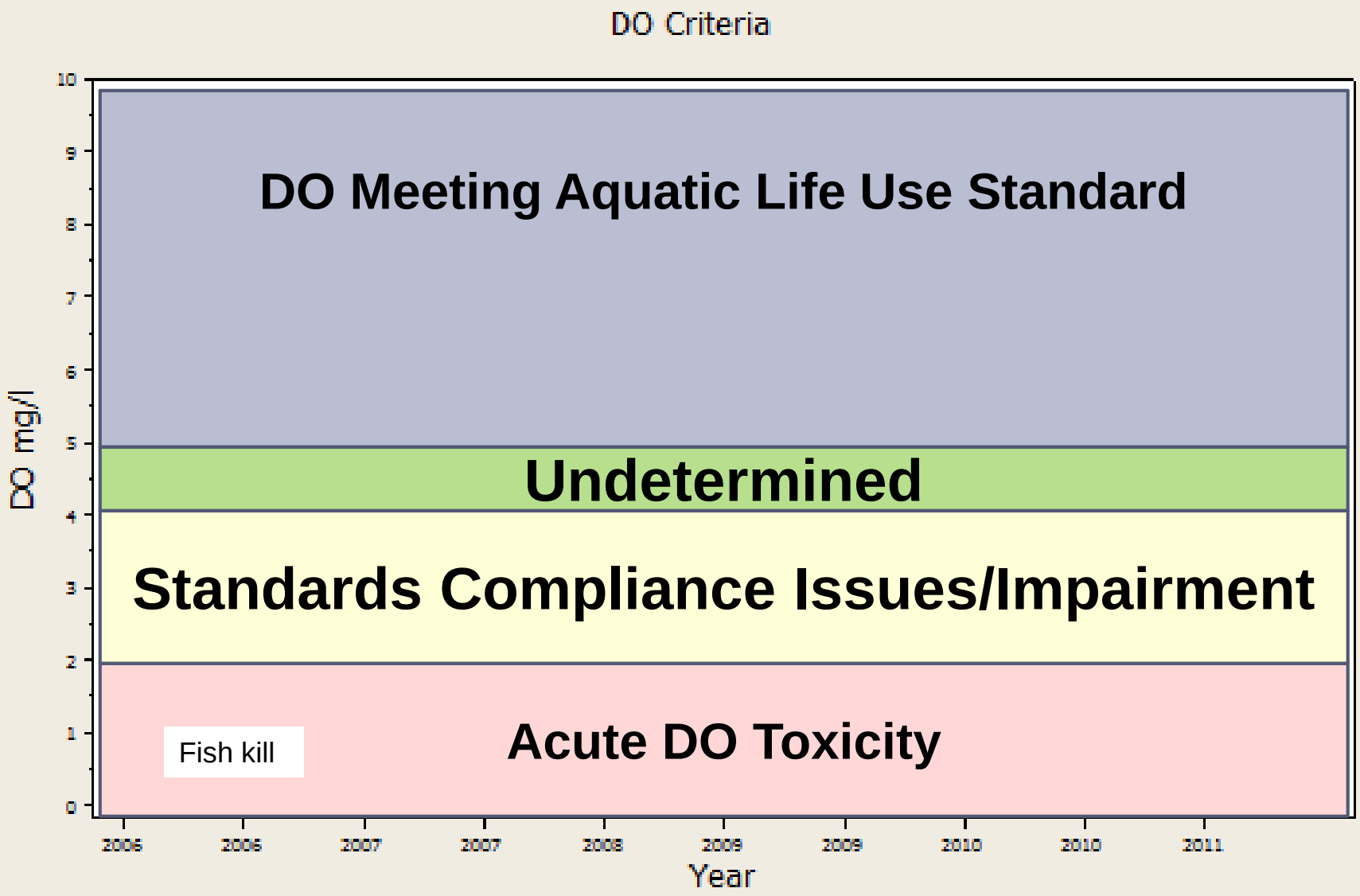
Oklahoma Water Resources Board (OWRB)

Grand River Dam Authority (GRDA) Reservoirs and Power Projects

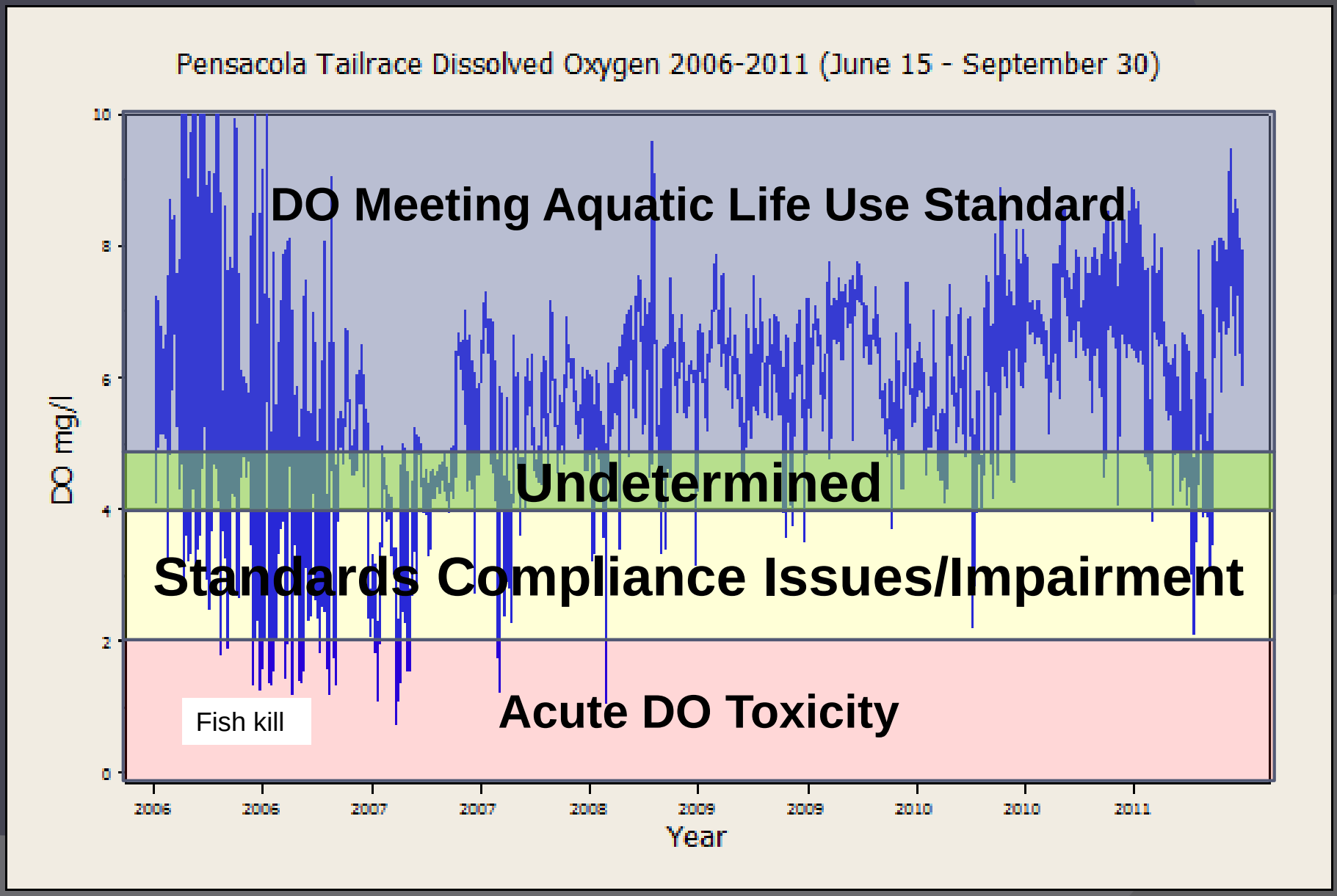
Grand River Dam Authority (GRDA) Reservoirs and Power Projects

- **Acute (fish mortality) and Chronic (regulatory) Dissolved Oxygen Problems in both Tailraces**
- **Required Development of Adaptive Management Strategies (empirically tested and modeled) for FERC re-licensing of GRDA's Pensacola and Kerr Power Projects**
- **Water Availability**
- **Study Design/Data Collection**

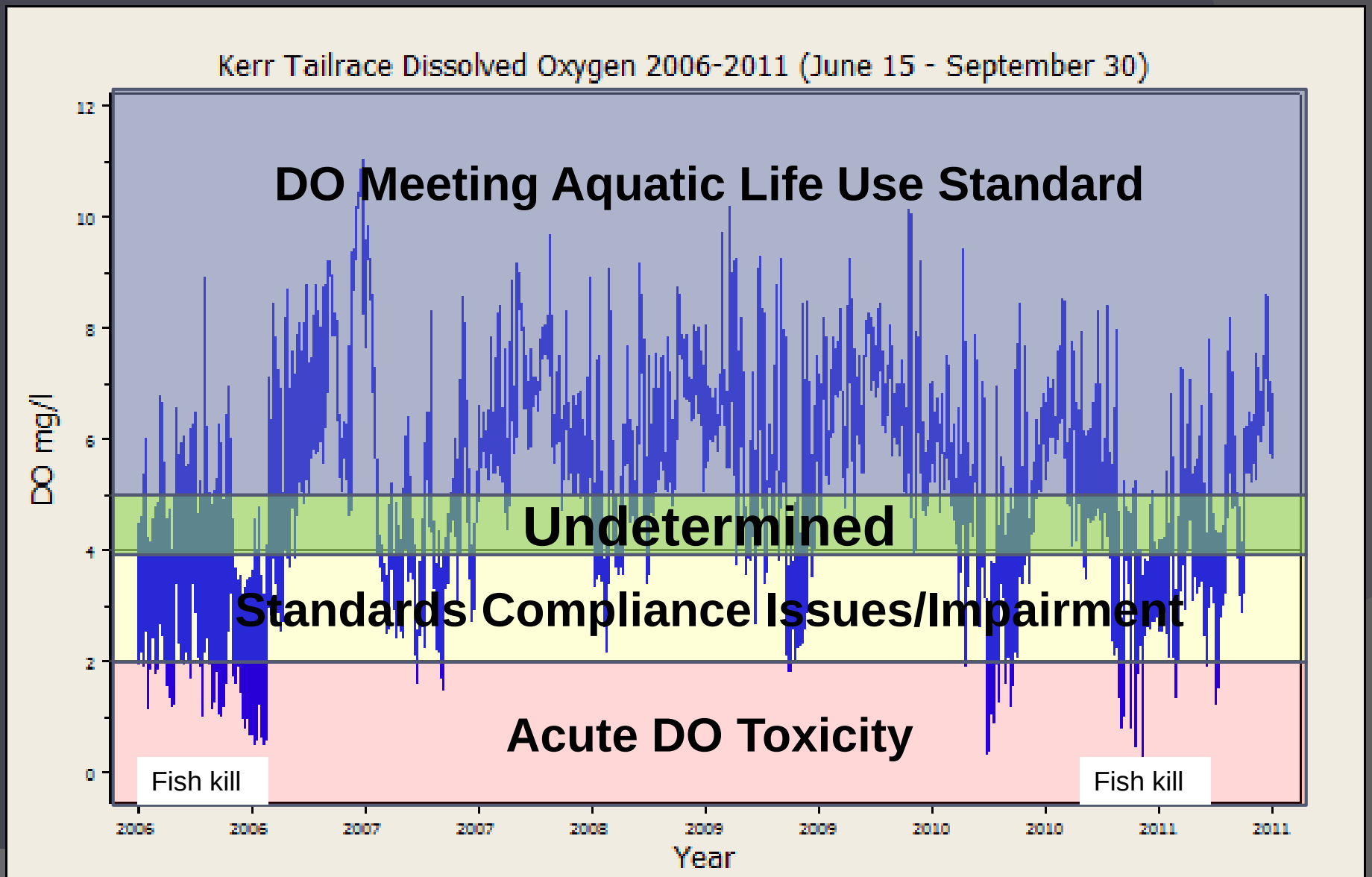
DO Aquatic Life Use Standard



Pensacola Dam Tailrace Standards Compliance



Kerr Dam Tailrace Standards Compliance

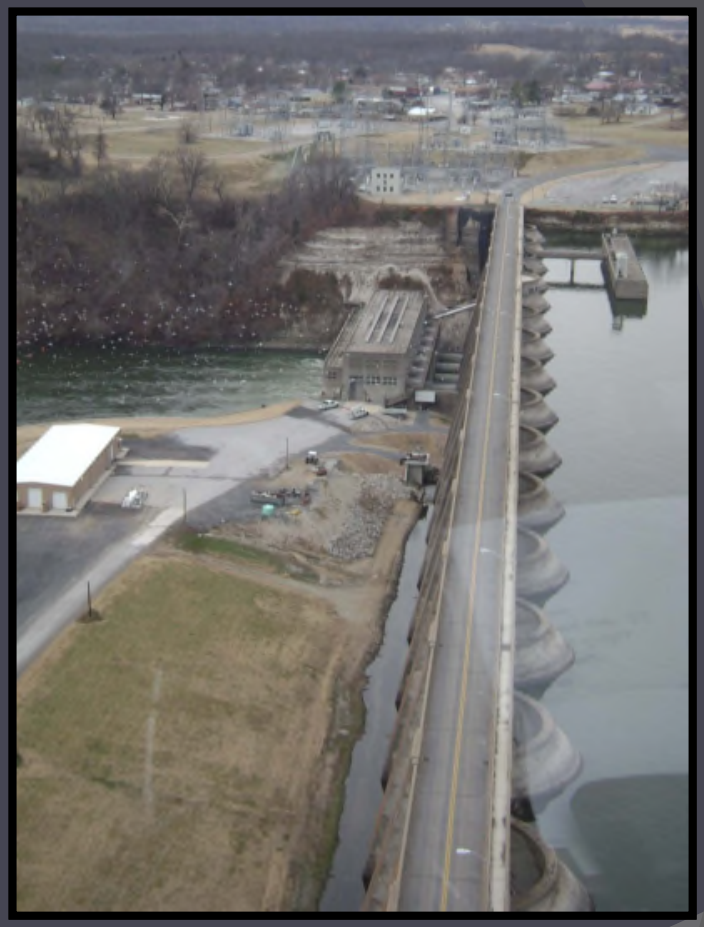


How do you solve the problem?

<u>Artificial Aeration</u>

- Weirs or fountains, e.g.
- Cost of installation
- Stability in highly volatile waters

How do you solve the problem?

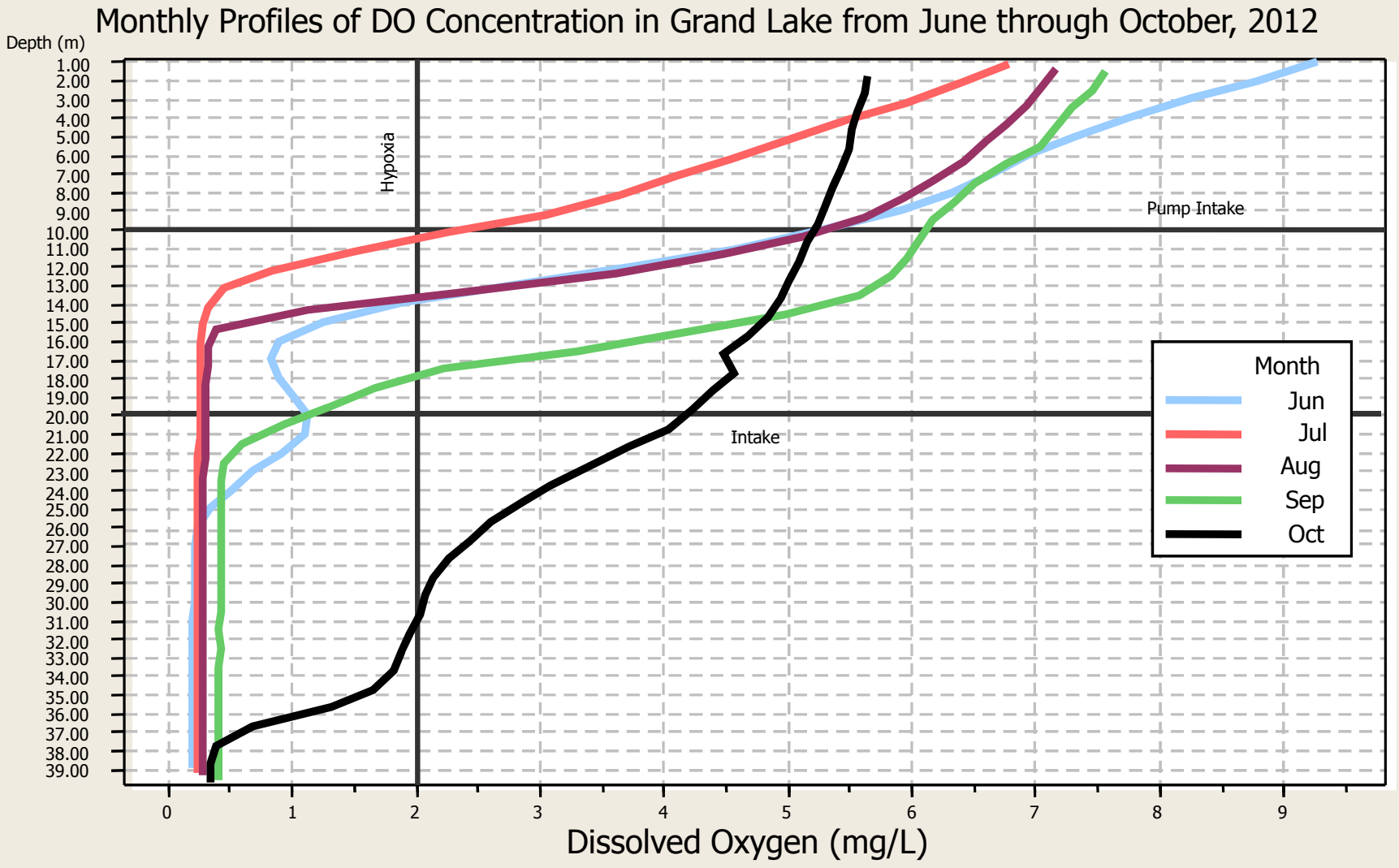


Source Water

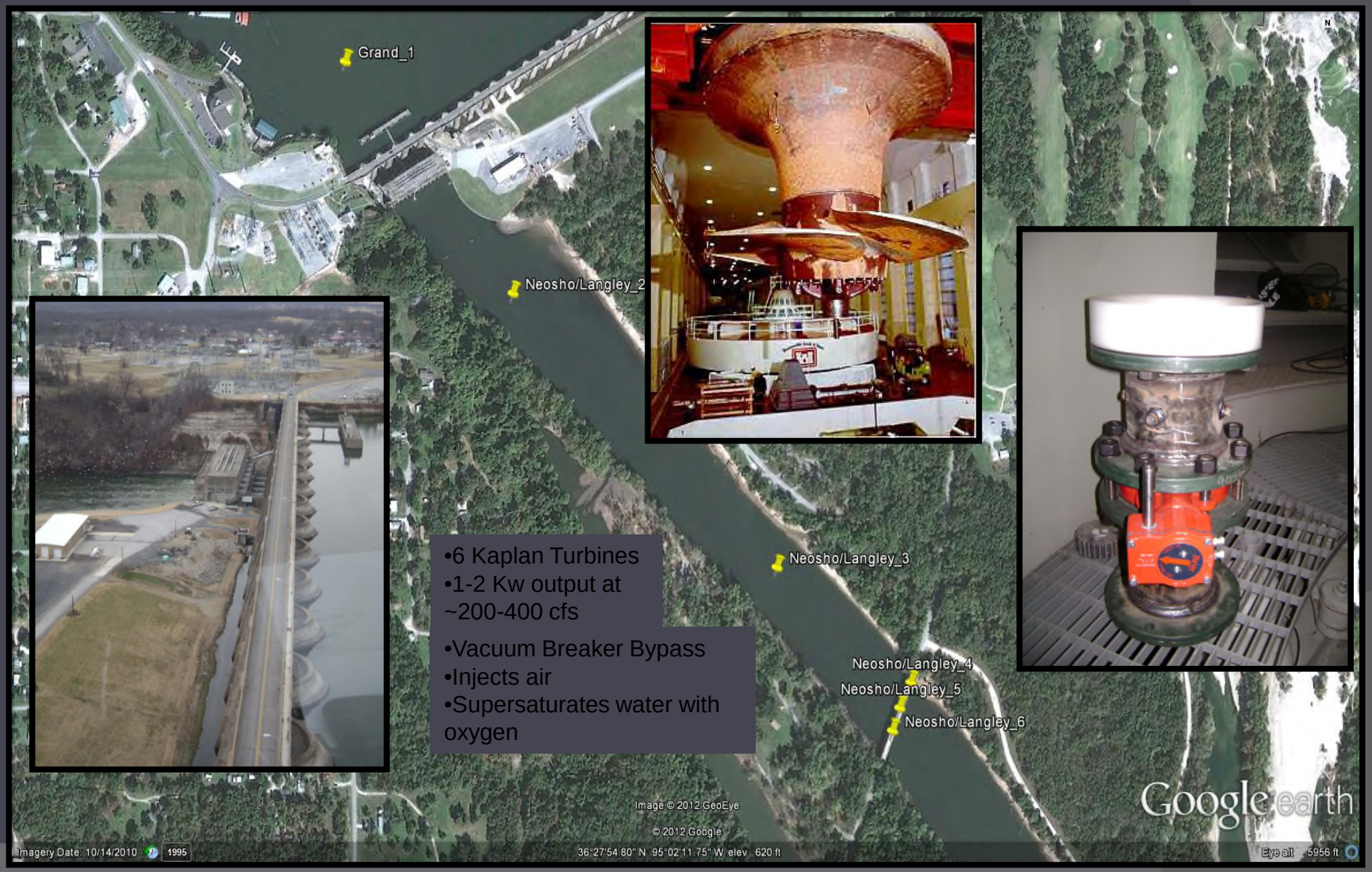
- Pumping, generation, spillage
- Availability of source water
- Quality of source water

Grand Lake/Pensacola Dam

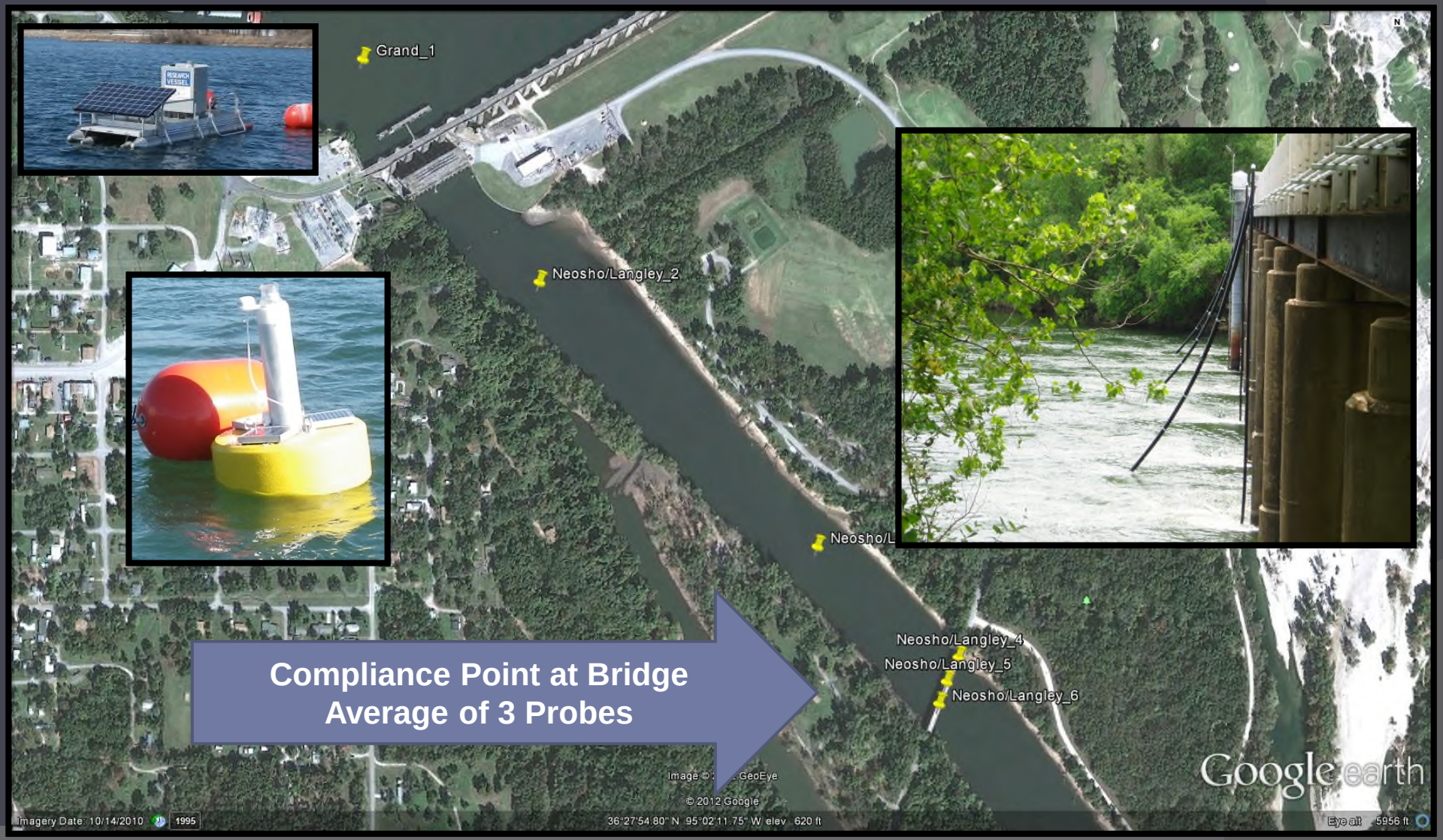
Grand Lake/Pensacola Dam



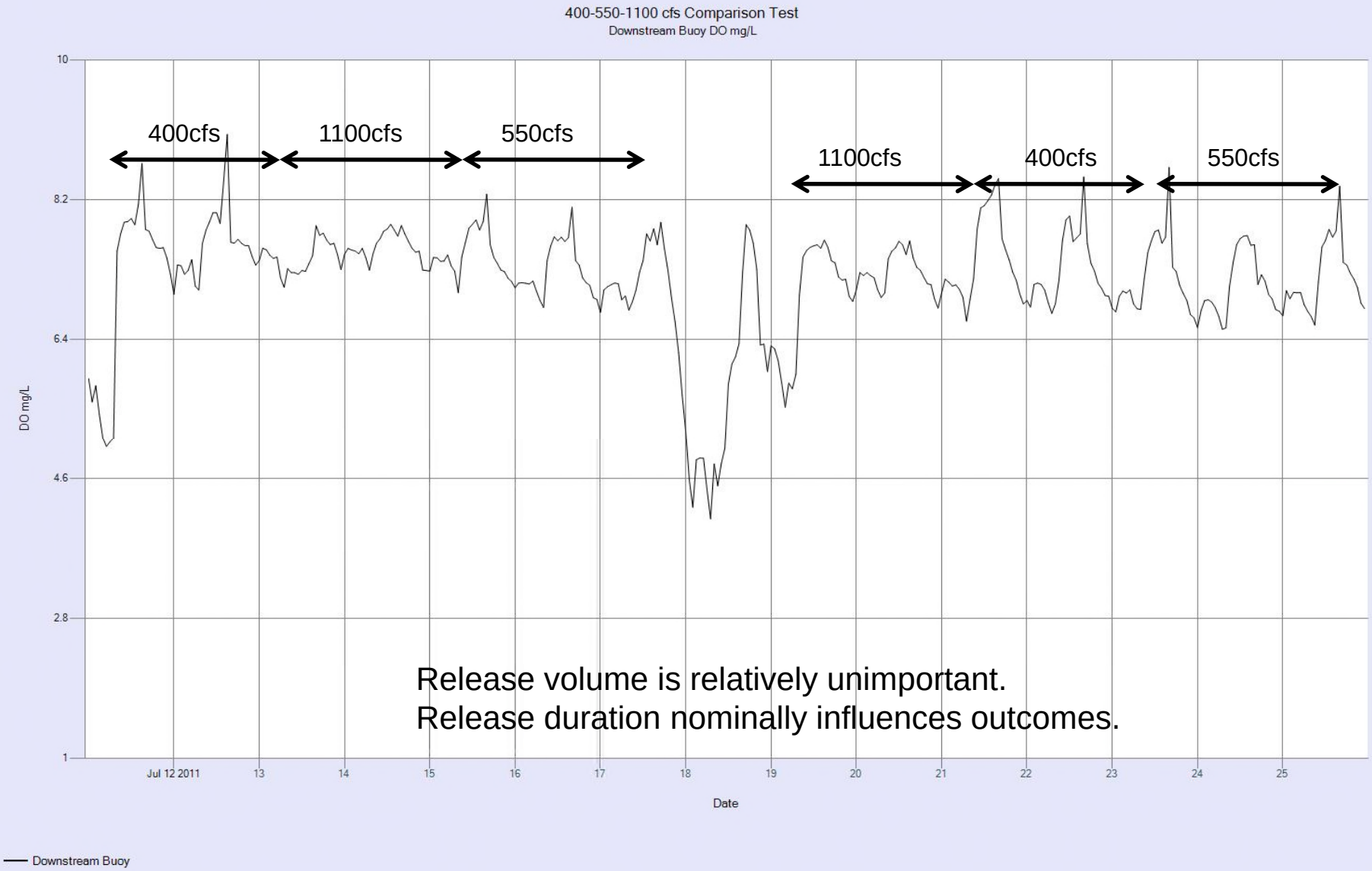
Grand Lake/Pensacola Dam



Grand Lake/Pensacola Dam Experimental Design



Pensacola Dam Generalized Test Results

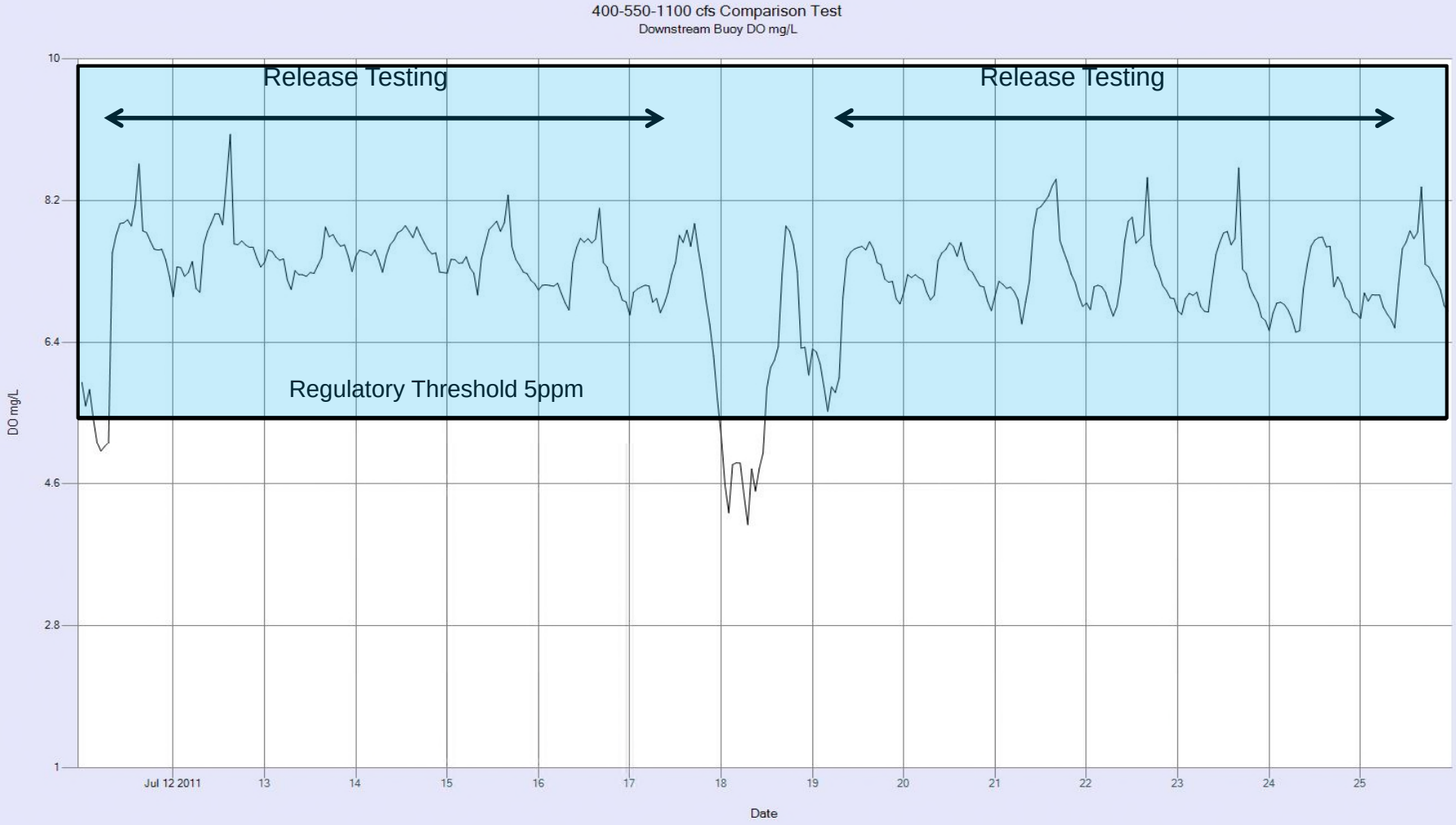


Pensacola Dam Generalized Test Results

Natural diurnal effect important to outcomes.

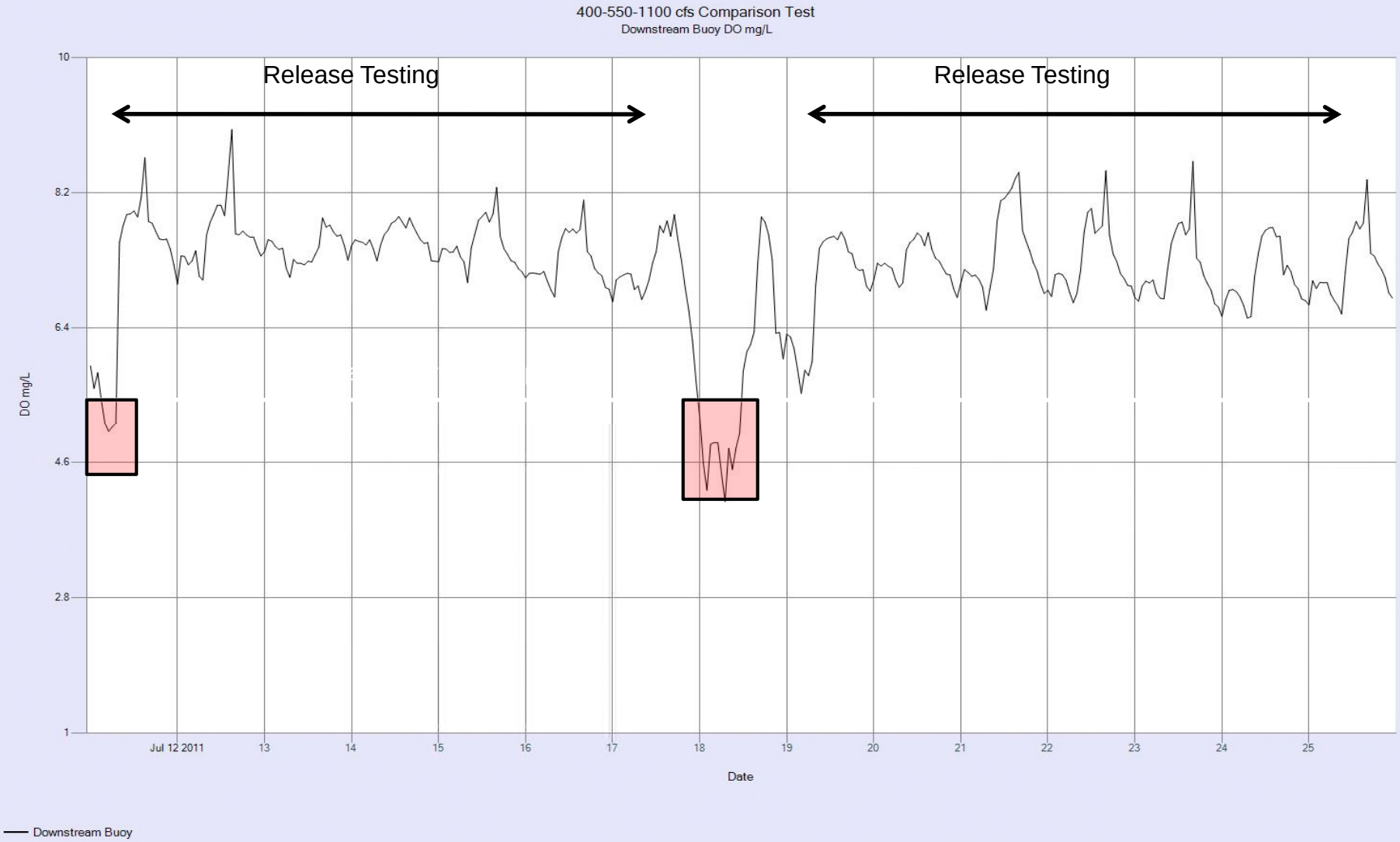
Pensacola Dam Generalized Test Results

Mitigation activities have an overall positive impact on both regulatory and ecological endpoints.



Pensacola Dam Generalized Test Results

Without releases have potential for regulatory impacts.



Pensacola Dam Adaptive Management Scenario

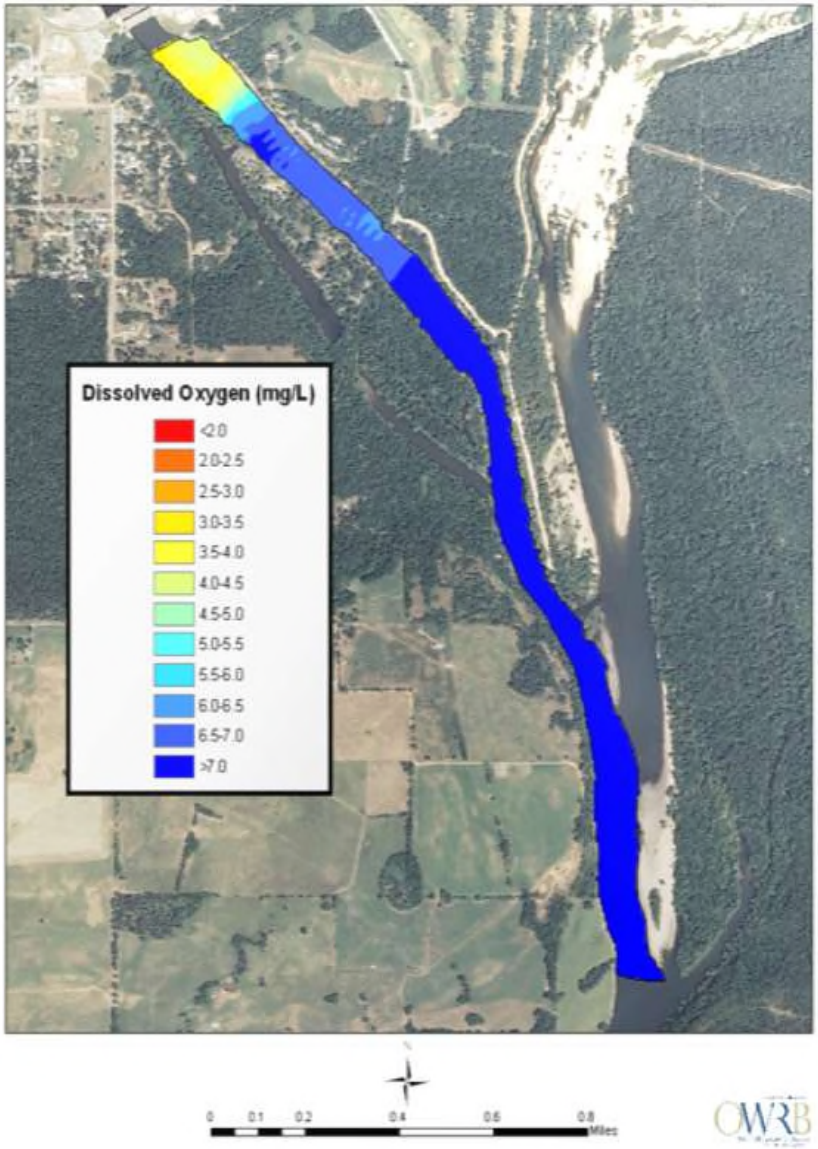
In an effort to meet the OWQS DO criterion and mitigate for potentially harmful effects to aquatic life, the following plan is recommend to be **implemented, beginning June 1, 2012**. Compliance will be measured at the three probes along the Langley Bridge. Any individual probe on the bridge will activate a mitigation response.

"**The action limit will be set at the OWQS criterion of 6mg/l from 10/16 though 6/15 and at 5 ppm from 6/16 through 10/15. Once the action limit is reached, according to an average of the Langley Bridge DO probes, one Turbine will begin running at 20% wicket gate (~ 320 cfs) with full aeration. Once a release is started, it will continue until the average DO value exceeds the criterion, but will continue for a minimum 6 hours. A second action limit will be set at 4.0 ppm. If the second action limit is reached, the first turbine will be upped to 25% wicket gate (~ 430 cfs) and will continue for a minimum of 2 hours. This operational plan will run year round and should ultimately be implemented as an automated process**."

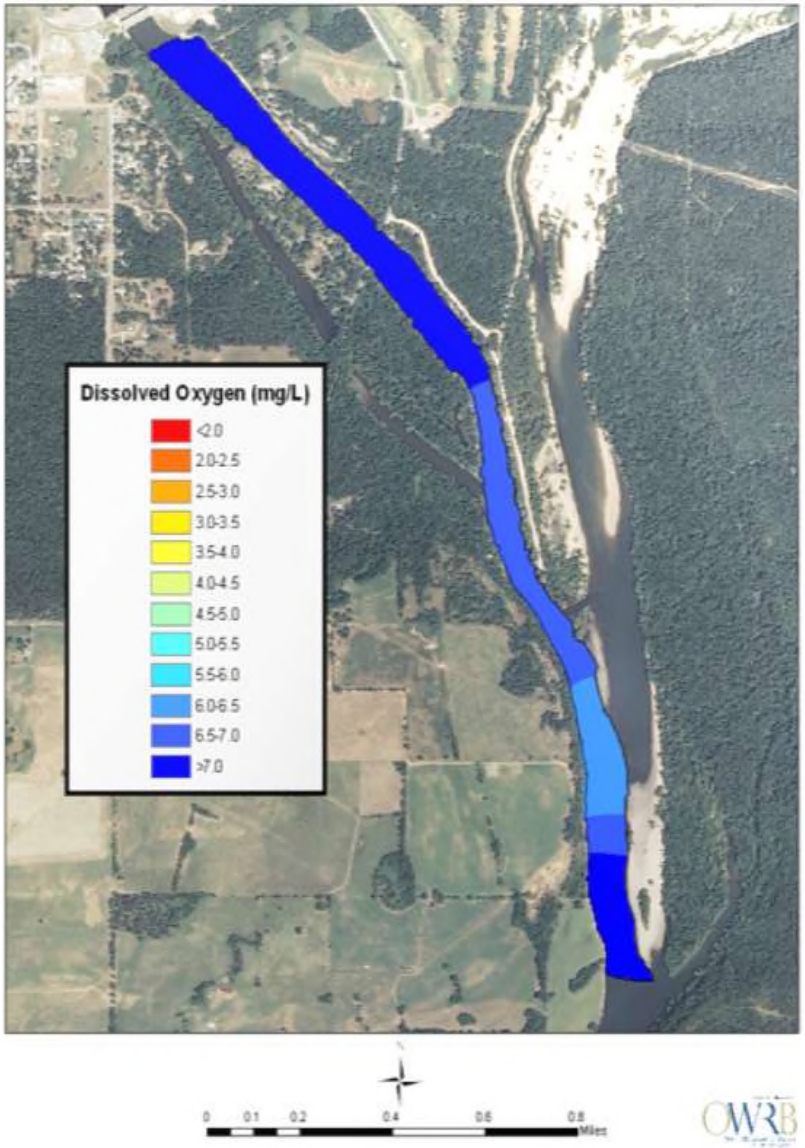
In an effort to facilitate the response process, an **e-mail alert system** will be set up to notify both operators and interested parties. When any individual compliance probe indicates a DO mg/L reading below any of the action limits, the NexSens iChart 6.0 software housed at the OWRB offices will send out an alert email to all necessary personnel at GRDA, FERC, ODWC, USFWS, and the OWRB. This email will indicate the most recently measured DO concentration and will state the appropriate response according to the mitigation plan. The program will reset the alert email as soon as measurements rise above the action limit.

This mitigation plan may be adjusted under several circumstances. Primarily, in the event that mitigation flows do not enhance DO concentrations, the OWRB will consult with all interested parties within 48 hours to determine the appropriate course of action. If enhancement does not work and concentrations reach acute DO levels (i.e., < 2 ppm), the OWRB will work unilaterally with the GRDA in an attempt to **develop an ad hoc mitigation scenario to avert a fish mortality incident**. All other technical committee members and FERC will be notified within 48 hours of any ad hoc mitigation scenarios. Second, if allowances to the regulatory rule curve are not eventually allowed, mitigation flows will likely cease if rule curve elevations are met.

Langley 7-03-2012 Control



Langley 7-04-2012 Treatment

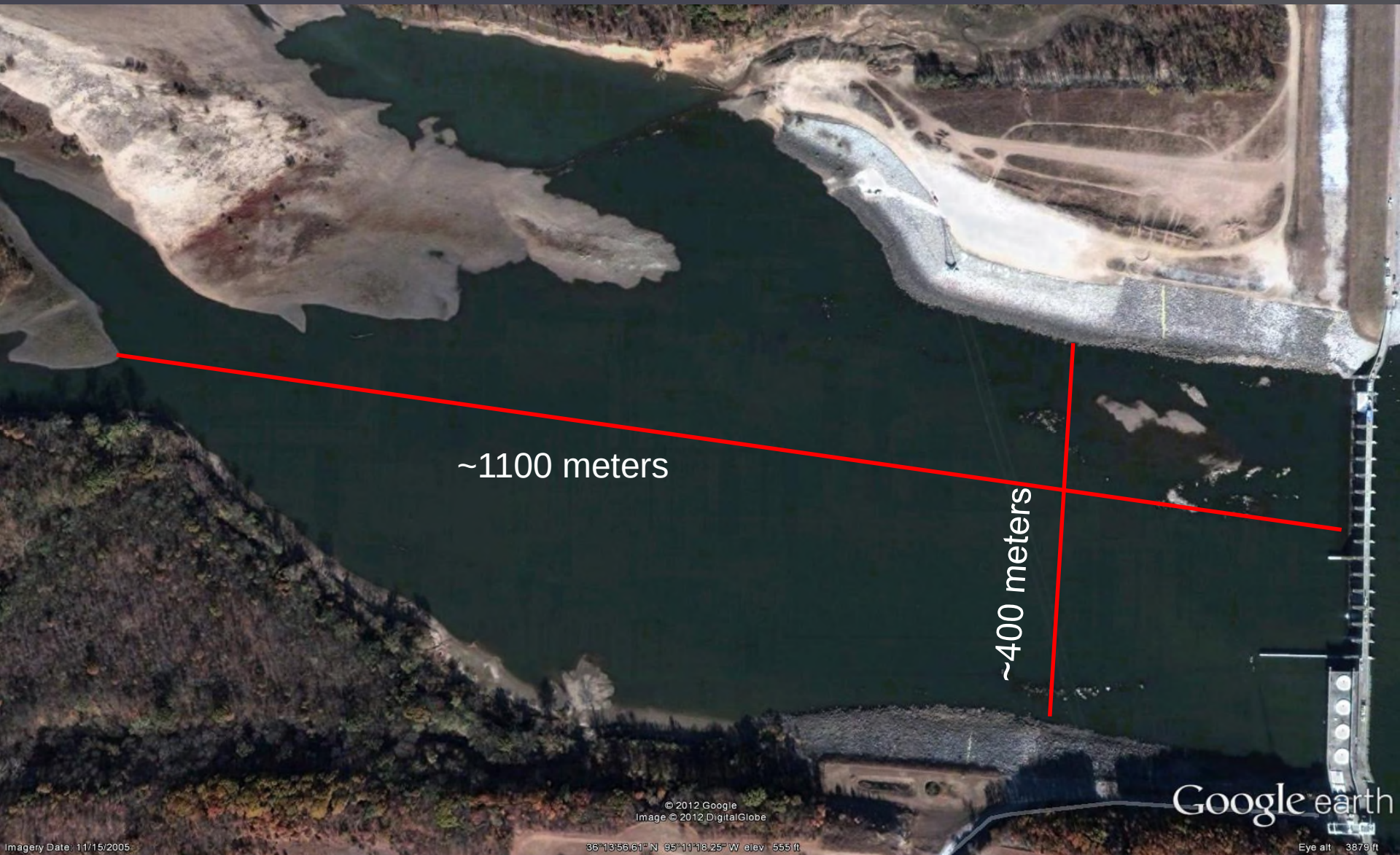


Lake Hudson/Kerr Dam

Lake Hudson/Kerr Dam

Different logistical issues

Difficult to mitigate consistently throughout both the tail race and stilling basin.



Kerr Dam Mitigation Scenarios

Injection of air using portable compressors
Continuous release from Tainter gates

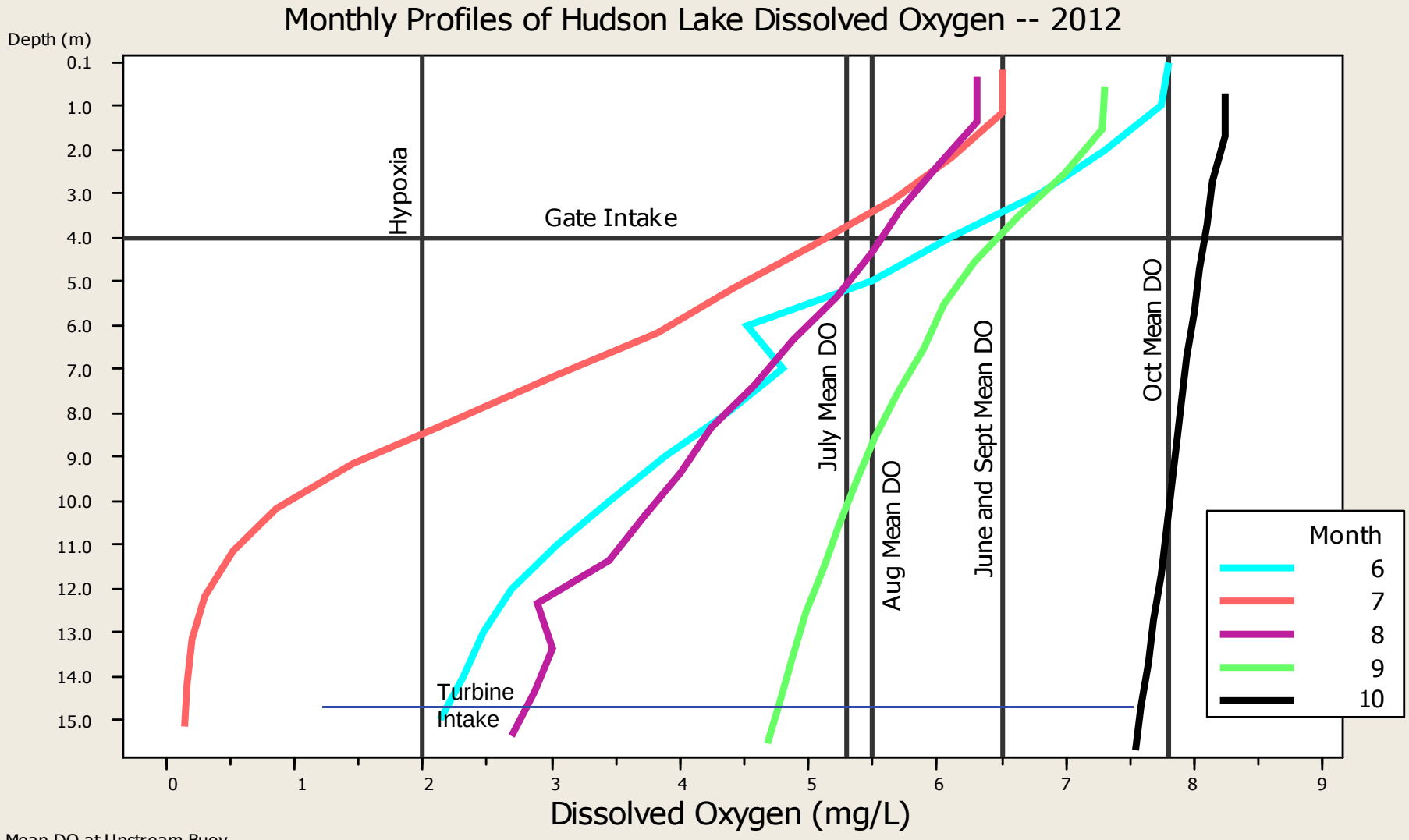
- Minimum release of > 350 cfs per gate
- Influences stilling basin and part of tailrace
- No air injection required
- Must be continuous

- Minimum release of > 2000 cfs
- Only influences tailrace
- Requires injection of air
- Noise pollution issues and cost

Kerr Dam Mitigation Scenarios

Injection of air at turbines

Continuous release from Tainter gates



Lake Hudson/Kerr Dam

Distinct Management areas

- large stilling basin
- small tail race.

Lake Hudson/Kerr Dam

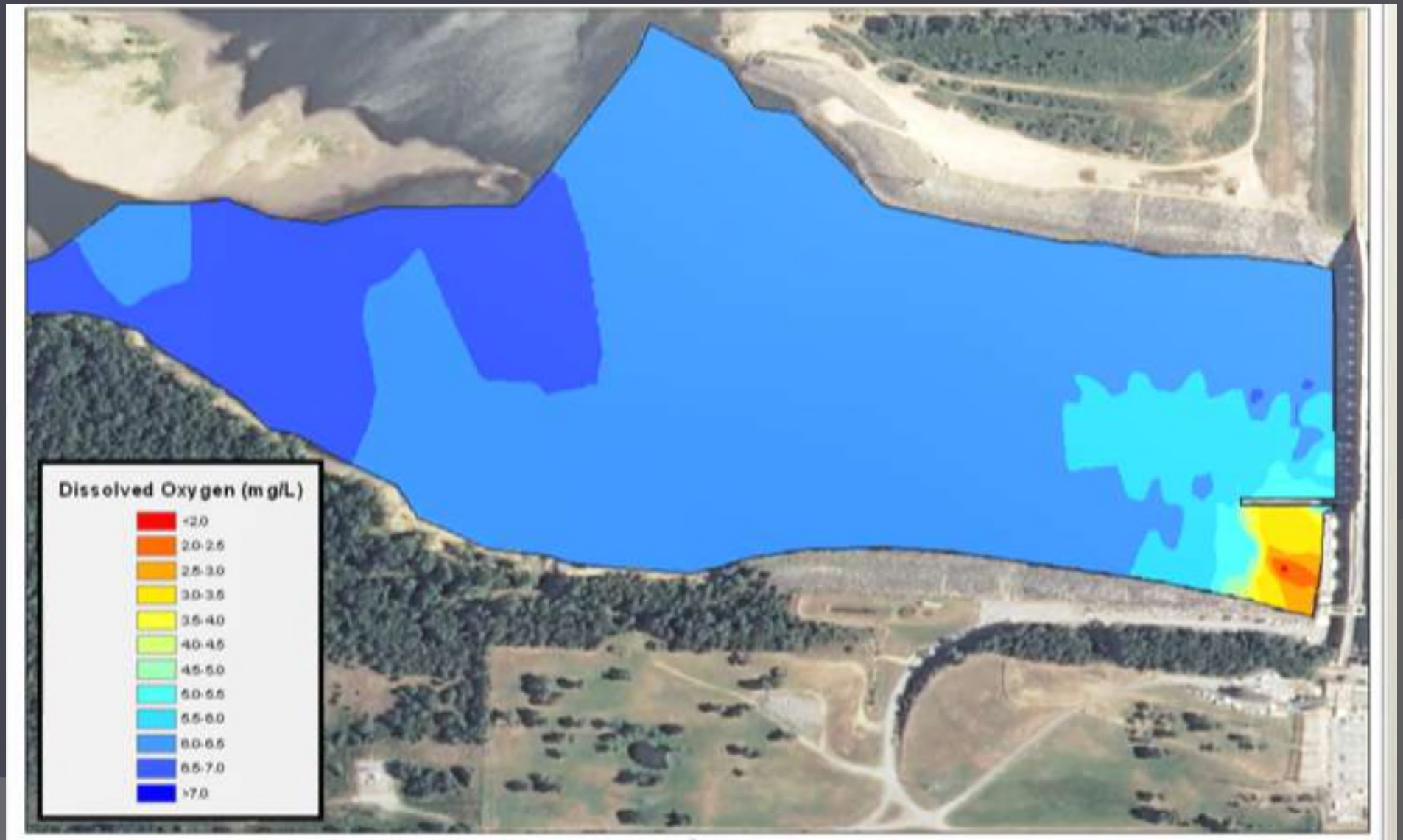
Either sacrifice the tailrace

Lake Hudson/Kerr Dam

…Or the stilling basin
Becomes an issue of finding adequate refugia for aquatic life

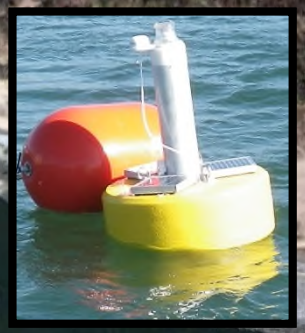
Kerr Dam Mitigation Scenarios

Blended mitigation through spillage



Kerr Dam

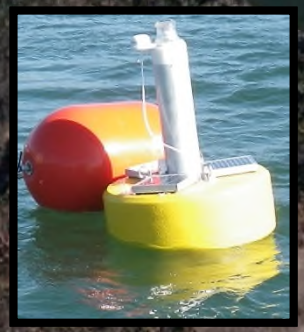
Compliance is an average of both upstream and downstream buoys.



Kerr Compliance 2

Kerr Compliance 1

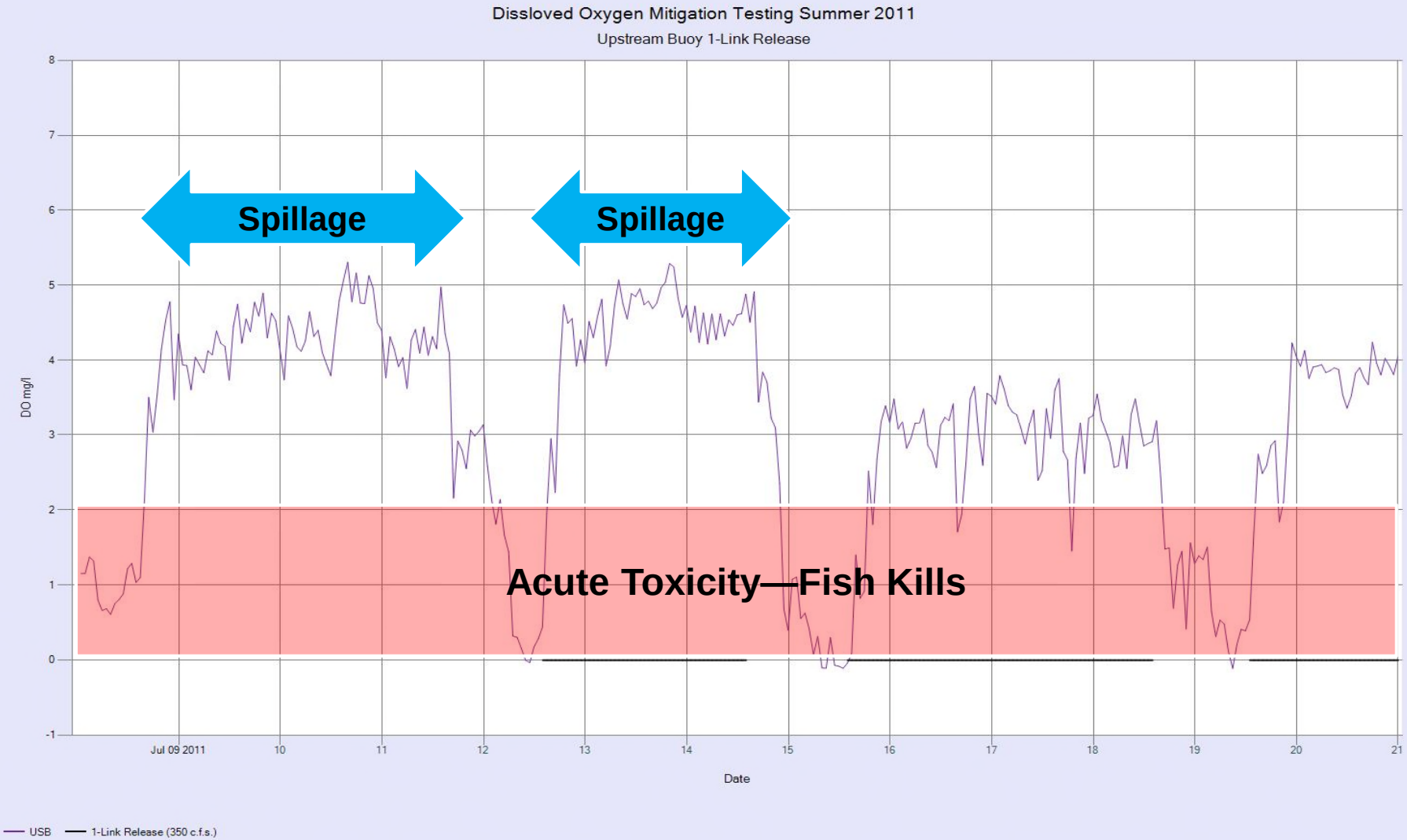
Kerr_1



Continuous 1-Tainter Gate Spillage from Dam; Ability to Open 2nd Gate

Kerr Dam General Conclusions

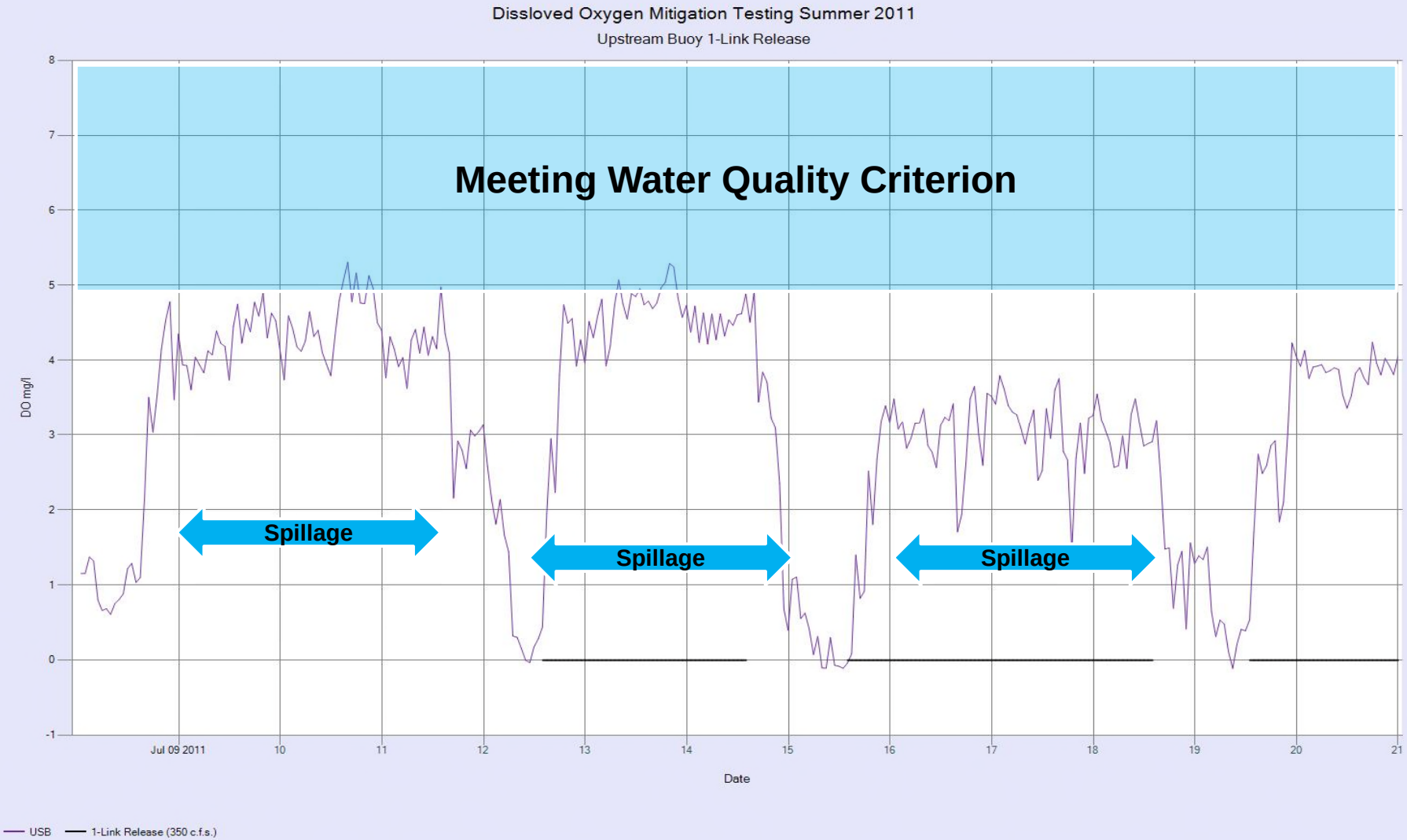
Two water quality management scenarios
Manage to avoid Acute DO toxicity



Kerr Dam General Conclusions

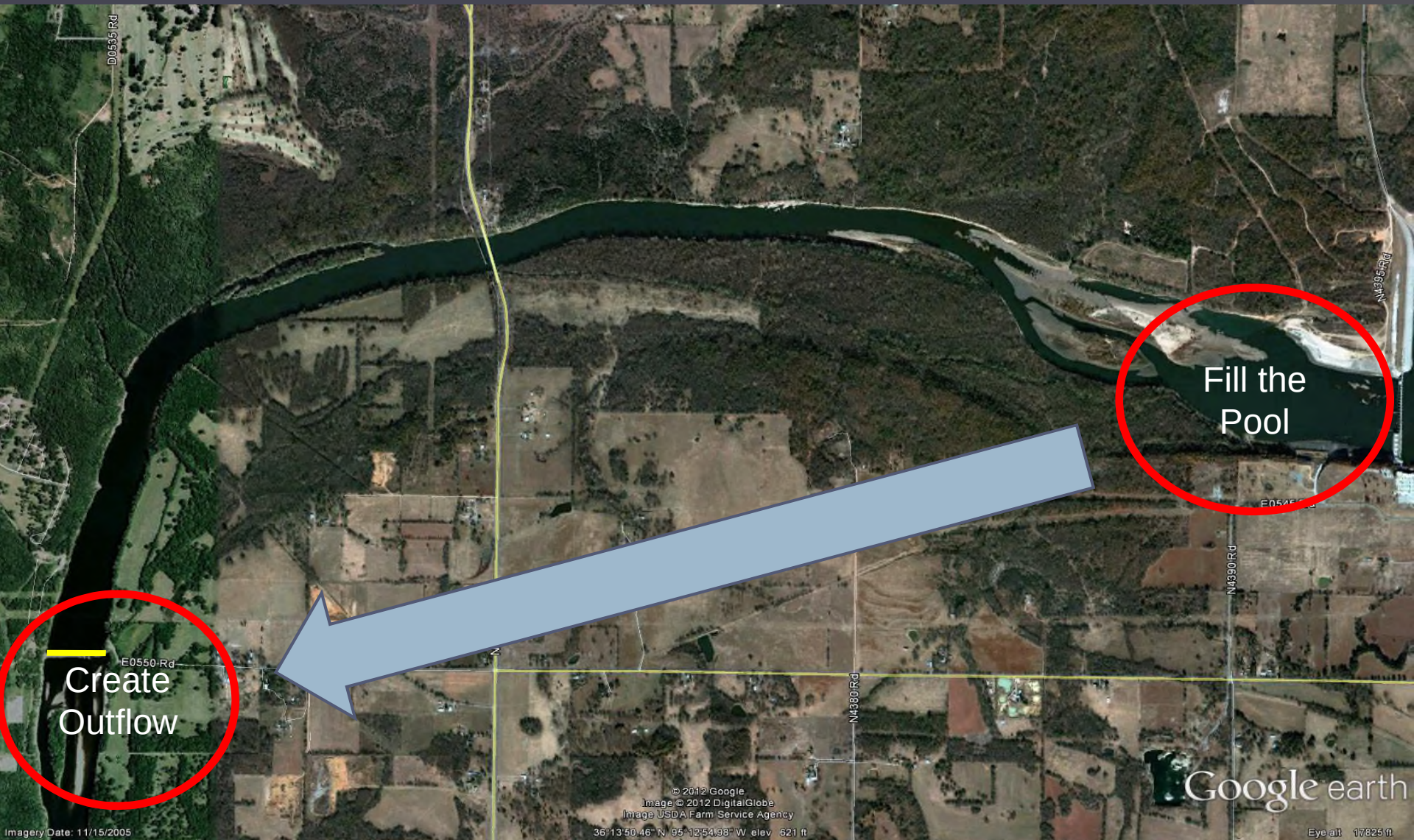
Two water quality management scenarios

Manage to meet Water Quality Criterion



Kerr Dam General Conclusions

Must create movement by raising the pool level.
Begin releases before DO issues begin.



Kerr Dam Adaptive Management Scenario

The following implementation schedule **will be implemented on June 1, 2012**.

"**Between the months of June 1 through September 30, a one chain link release from the spillway will be used to mitigate acute and nuisance DO conditions. When either median daily DO values fall below 5ppm for a 48 time period or when greater than 4 15-minute samples fall below 3ppm in any 24 hour period, the mitigation release be used continuously until 90% of samples are above 5ppm and no values are below 2ppm over a consecutive 7-day period, or until Hudson Lake falls below the regulatory rule curve. If any single value is less than 1ppm, the mitigation scenario will be implemented and continue until the afore-mentioned conditions are met. The Compliance stations will be used jointly to provide data for use in managing implementation (Figure 68). Testing will continue to document variance in DO concentrations during the continuous release periods. The 24 and 48 hour time periods run from 0600 to 0600 hours over two consecutive days**."

In an effort to facilitate the response process, an **e-mail alert system** will be set up to notify both operators and interested parties. When any individual compliance probe indicates a DO mg/L reading below any of the action limits, the NexSens iChart 6.0 (NexSens, 2012) environmental software housed at the OWRB offices will send out an alert email to all necessary personnel at GRDA, FERC, ODWC, USFWS, and the OWRB. This email will indicate the most recently measured DO concentration and will state the appropriate response according to the mitigation plan. The program will reset the alert email as soon as measurements rise above the action limit.

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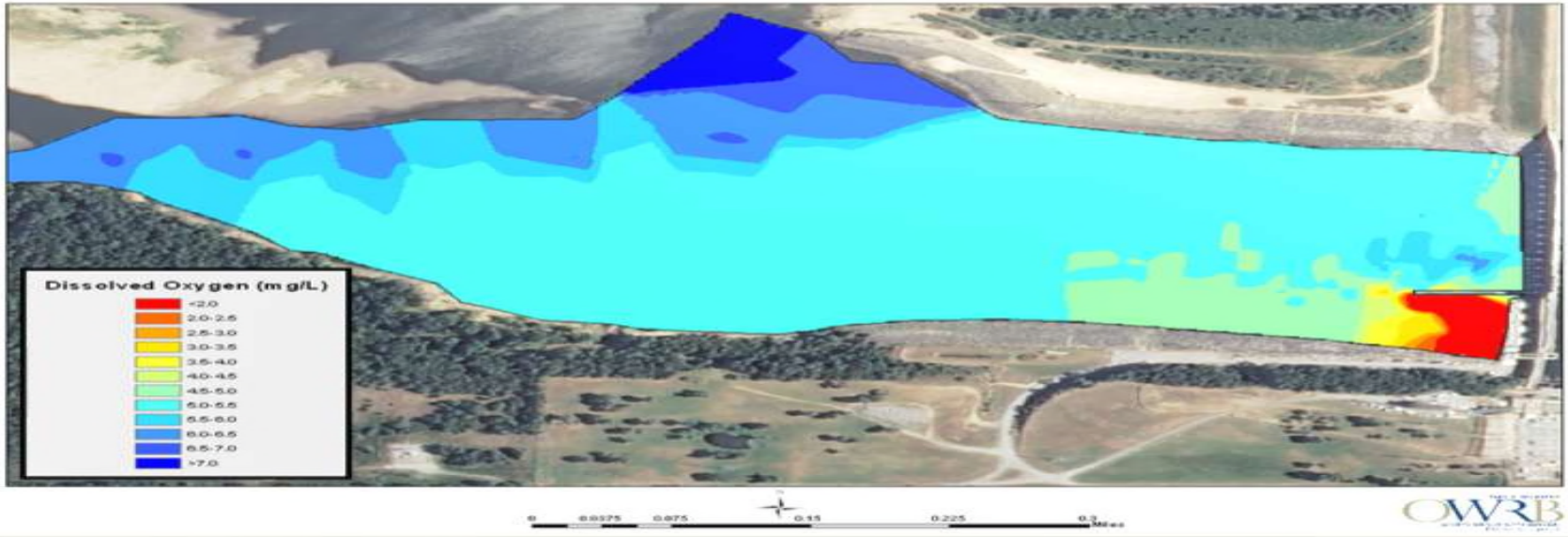
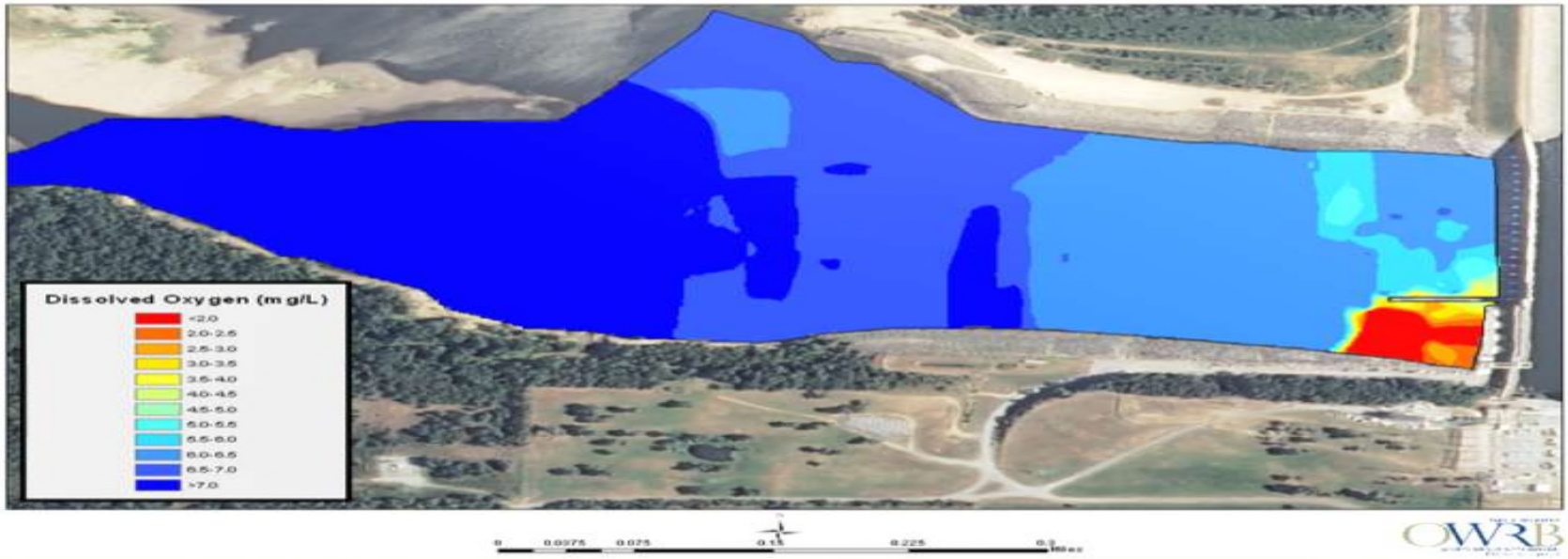
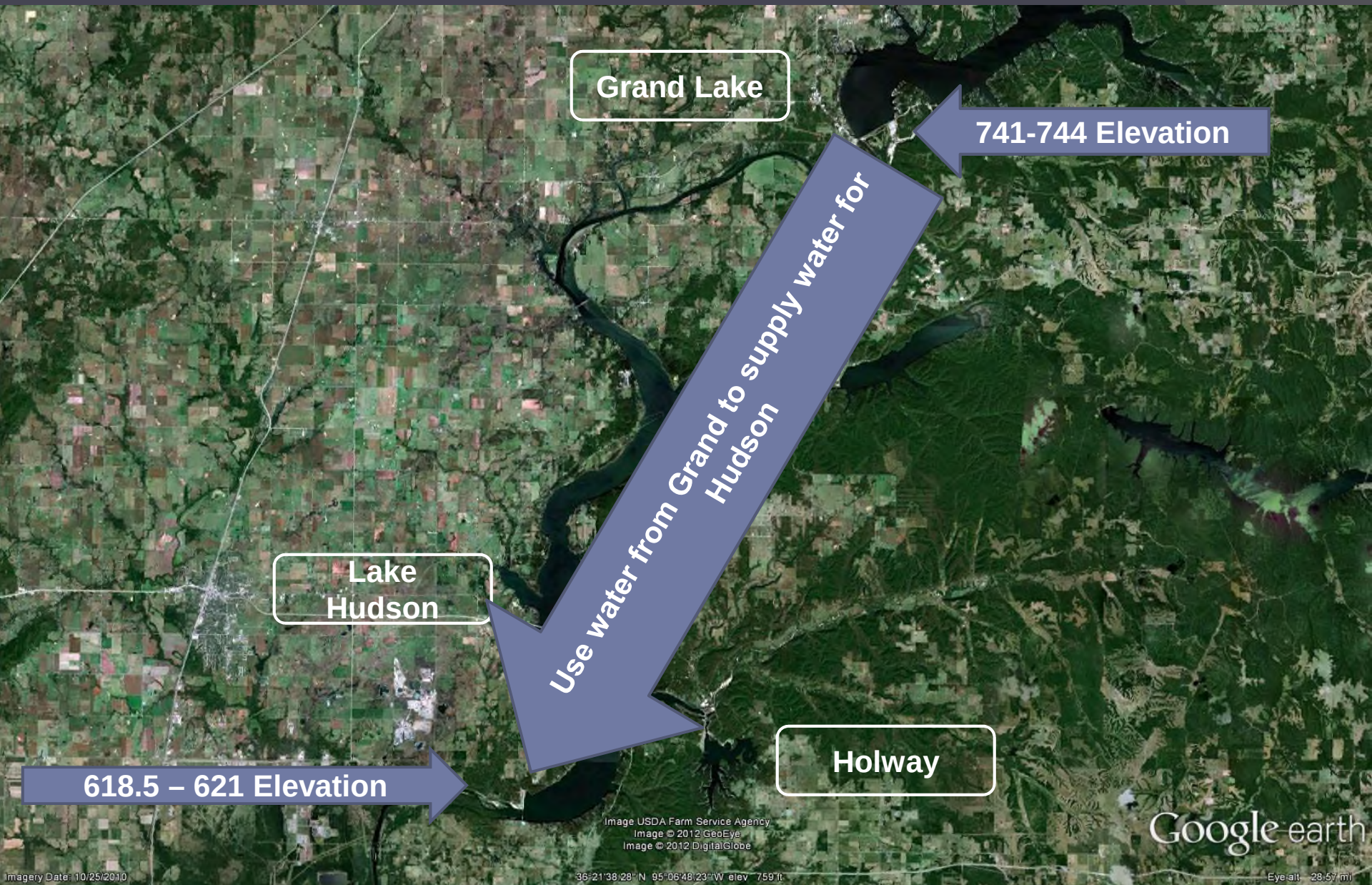
Kerr 7-30-2012 Control



Kerr 8-01-2012 Treatment



Holistic Watershed Management

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